North Carolina
Coastal Federation

Appropriate Grade Levels: 3-5th

Standards Addressed:

NC Essential Standards: 3.L.2, 4.E.2.3 and 4.L.1.3

Common Core: 4 MD A.1

Next Generation Science Standards: 3-ESS3-1, 4-ESS 2-1 and 5-ESS3-1

Setting: Indoors/ Outdoors/Lab

Approximate Time of Lesson: 75 minutes

Learning Objectives:

- Identify what a living shoreline is compared to a bulkhead/ seawall.
- Compare and contrast different methods of erosion control.
- List three types of shoreline protection methods.
- Describe which protection methods create more habitat for animals.

Shifting Shorelines

Summary:

Students will explore how various shoreline stabilization methods influence coastal erosion and the surrounding habitat. They will rotate through four stations: a bare sand shoreline, a hard structure protection method, a living shoreline with planted marsh grasses, and a living shoreline with both planted marsh grasses and a constructed oyster reef. While rotating through the stations in small groups, students will simulate wave energy and observe which method works best to protect estuarine shores.

Materials:

- 4 clear plastic containers (we used 11 in X 16 in, 15 Qt.)
- Sand (one bucket full)
- Playdoh (*air dry clay will dye the water, so use Playdoh or Crayola Dough)
- Water
- Aquarium grass used in fish tanks
- 2 small vinyl siding samples from Lowes Hardware (for bulkhead/seawall)
- Small mesh bags with small pebbles/rocks inside (for oyster reef)
- Rubber bands
- 4 small paint scrappers (or something which allows students to make waves if you don't want them using their hands)
- Towels
- Saran /Plastic Wrap
- 4 Rulers (one for each station)
- Colored or Masking Tape for each station
- Shifting Shorelines Worksheets (included)
- Printed images of different shoreline protection methods (included)

Resources Needed for Educators: White board or something to label and tape images to during introduction. White board markers. May want a timer to assure students are consistent in their move from station to station.

Vocabulary: Shoreline, Estuary, Erosion, Deposition, Transportation, Living Shoreline, Hard Structure, Bulkhead, Seawall, Oyster Reef, Habitat, Salt Marsh, Wave Energy

Background Reading for Teachers:

Coastal Review Online article about living shorelines vs. bulkheads:
http://www.coastalreview.org/2016/02/12896/

Video on salt marsh habitats:
https://www.youtube.comwatchv=3HXyTMnj7ac&list=PL2TM_ytWoSRxqGED0kddEoiboHYtwH74F&index=2

Estuary background:
https://www.youtube.com/watch?v=W7_p6c1woHg

Protecting salt marsh and estuarine habitats is vital for a healthy coast. An estuary is where rivers meet the sea and salt water combines with fresh water to create *brackish* water. A salt marsh is a coastal habitat that forms between the land and the estuary, and is dominated by grasses. The salt marsh and estuary are nursery areas for many fish and other aquatic animals.

In North Carolina, there are several techniques used to protect estuarine shorelines from **erosion**. Coastal erosion is the loss of surface land and can be caused by rising water levels and waves from boat wakes, wind and storms. Many times, hard structures such as **bulkheads or seawalls** are used to protect local shorelines. Over time, these structures require expensive maintenance and can fail, specifically during large storms such as hurricanes. They also scour the valuable intertidal habitat seaward of them.

Living shorelines are another method used to protect tidal shores from erosion. Unlike traditional techniques such as jetties, groins, and bulkheads, living shorelines use natural elements like oyster shells or native marsh grasses. These natural elements work to stabilize the shore and provide critical habitat at the same time.

Living shorelines offer many benefits, including:
providing food and shelter for many creatures
serving as critical nurseries for important marine species
filtering pollutants from stormwater runoff, the number one source of pollution along the N.C. coast
protecting the land from wave energy, storm surges and tides
providing aesthetic value, enhanced views, and a sense of place

However, in a small percentage of situations, living shorelines may not be appropriate due to high level wave energy.

Activity:

Engage:

(20 minutes) Take students on a walk outside to observe where soil has worn away or collected in certain locations. Look by curbsides, vegetation, drains, playground areas etc. Talk to the students about erosion and deposition and ask them to point out whether they think different conditions are due to erosion (soil worn away) or deposition (collection of soil). Ask students if they have ever noticed erosion or deposition along a shoreline or at the beach?

(5-10 minutes) On a board write “only sand”, “bulkhead/seawall”, “living shoreline with grass” and “living shoreline with grass and oyster reef”. Tape images of the 4 different shorelines (included in images) under their description. Have students name and add a tally mark underneath the shoreline they think will do the best job protecting the land/sand in places when waves come. The images will provide visual clues for students.

Let the students know that these images show different ways that estuarine shorelines can look or be protected. Review what an estuary is if necessary.

Explore (25 minutes):

Split students into 4 small groups (ideally 2-5 students). Allow the students to rotate through 4 stations, which simulate an example of each shoreline (in plastic tubs- see appendix).

At each station, students will observe how wave energy influences the sand on the shoreline, by gently moving the water to make 20 waves.

Have the students mark with tape where the shoreline ends before they make waves, and again after the 20 waves. They can then use a ruler to measure how much of the shoreline eroded from the original piece of tape.

Have each student fill in the *Shifting Shorelines* worksheet (included in appendix, 4 pages total) to make observations while they move through the stations. Allow the groups 5-10 minutes at each station to take turns making waves and record their thoughts on the worksheet.

Review rules for using the water:

Keep waves gentle. Demonstrate to the students how to make a proper wave. No splashing other students. Students can use their hands or the paint scraper to generate the waves (depending on how messy you want them to get). They can also split up the waves per station so everyone has an equal chance to "make waves".

*Have students repair their shoreline back to the condition they found it in before allowing a rotation to occur, including removal of tape from the outside of the container.

Explain (5 minutes):

After rotating through all of the stations, allow the students to discuss the different shorelines in their small group. On their worksheets, have students answer Part 1 of the Review Questions (on page 4 of the worksheet):

Which shoreline lost the most sand during the wave experiment?
Which shoreline kept the most sand during the experiment?
What happened to the sand? Where did it go? Why did this happen?
What do you think would happen if a hurricane came to the shorelines?
What do you think the different shorelines would look like a year after the hurricane?
How do you think the plants and oyster reefs can help keep the surrounding water clean? (*plants can help filter any pollutants coming from the mainland, and the oyster reefs will attract new oysters, which naturally help clean and filter water)*

Review these questions with the class and ask some students to share their answers. For #5, make sure students realize that plants may be able grow back after strong storms come through.

Teacher: Simulate hurricane force waves by rocking the tubs so students can see what happens and discuss. You may want to show a short video on NC hurricanes.

Elaborate (10 minutes):

On their worksheets, have students answer Part 2 of the Review Questions (found on page 4 of the worksheet):
If you had a home in front of the shore, which type of shoreline would you want? Why would you want that shoreline instead of another one?
Which shoreline do you think would be a better home for fish and other animals?
Why do you think the shorelines with plants and oyster shells were called "living shorelines"?
Review these questions with the class and ask some students to share their answers.

Evaluate (5 minutes):

-Have students come back up to the board, and mark a tally underneath the shoreline example they now think is best at protecting the land using a different color marker (or draw a line to denote the before and after thoughts). If some students have changed their answers from before, ask them to share why they did so.

-Closure: Review the lesson with students. Sample script: *Today we learned about different ways to protect our shorelines from erosion. What causes erosion? What were the different shoreline protection methods? Which protection method did the best job at keeping the shoreline safe? Which protection method provided the best habitat*

*for plants and animals? How did the marsh plants help hold the sand in place? (*roots)*
-Have students complete and turn in their Shifting Shorelines worksheet.

Extensions:

-Have students research salt marshes and estuarine habitats to see what types of animals may live in a living shoreline.
-Visit shorelines with varying types of stabilization methods.
-Work with the North Carolina Coastal Federation to schedule field trip where students plant marsh grasses along an estuarine shoreline to restore a coastal salt marsh.

Appendices:

To build shorelines:

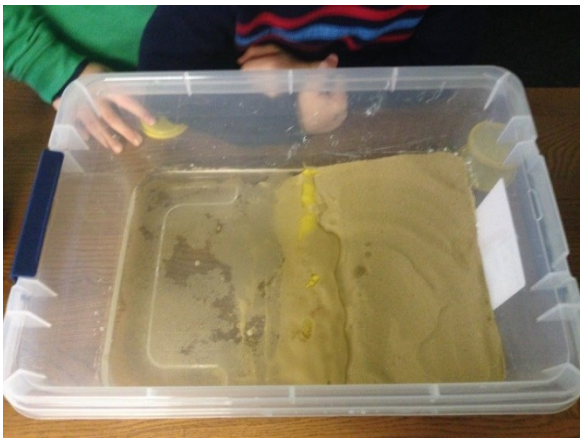
Only Sand & ALL other shorelines: Place a one inch layer of playdoh at the bottom of the shoreline section (about 1/3 toward one end of the container). Place one layer of saran/plastic wrap over top of the playdoh (this will help with cleanup). Add sand on top of the playdoh, and form a gentle slope to create a beachfront/shoreline. Add water to the opposite end of the container so it reaches roughly ¼ of the sandy shore.

Bulkhead/seawall: Add the small vinyl siding samples and place them side by side. Stick them down into the playdoh.

Living shoreline with plants: Add aquarium plants and bury down in the sand/playdoh a bit to represent plant roots. You may need to cut the aquarium plants so they fit in your container correctly.

Living shoreline with plants and oyster reef: Add plants and then place pebble bags slightly in front of plants. You may need to use rubber bands around the pebble bags to make the reef more streamline. See images below.

Only Sand:



Bulkhead/Seawall:

Living Shoreline with planted marsh grass:

Living Shoreline with planted marsh grass and oyster reef:

Name: _____

Shifting Shorelines Student Worksheet

Station #: _____

Station Name: _____

1. **Draw a picture of what the shoreline looks like before any waves:**

2. **Make a Prediction:** What do you think will happen when waves come up to this shoreline?

3. **Take a piece of tape and mark where most of the sand stops on the outside of the shoreline container.**
4. **Gently make 20 waves along the shoreline. Mark where the sand stops with another piece of tape on the outside of the shoreline container.**

5. After all of the waves, did the shoreline shrink any?

6. **Use a ruler to measure how far the sand traveled from the first piece of tape you added to the last piece of tape you added.** How many millimeters did the shoreline move back from the start of the experiment to the end? How many centimeters?

7. **Draw a picture of what the shoreline looks like after all 20 waves:**

Station #: _____

Station Name: _____

1. **Draw a picture of what the shoreline looks like before any waves:**

2. **Make a Prediction:** What do you think will happen when waves come up to this shoreline?

3. **Take a piece of tape and mark where most of the sand stops on the outside of the shoreline container.**
4. **Gently make 20 waves along the shoreline. Mark where the sand stops with another piece of tape on the outside of the shoreline container.**

6. After all of the waves, did the shoreline shrink any?

7. **Use a ruler to measure how far the sand traveled from the first piece of tape you added to the last piece of tape you added.** How many millimeters did the shoreline move back from the start of the experiment to the end? How many centimeters?

8. **Draw a picture of what the shoreline looks like after all 20 waves:**

Station #: _____

Station Name: _____

1. **Draw a picture of what the shoreline looks like before any waves:**

2. **Make a Prediction:** What do you think will happen when waves come up to this shoreline?

3. **Take a piece of tape and mark where most of the sand stops on the outside of the shoreline container.**
4. **Gently make 20 waves along the shoreline. Mark where the sand stops with another piece of tape on the outside of the shoreline container.**

6. After all of the waves, did the shoreline shrink any?

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8. **Draw a picture of what the shoreline looks like after all 20 waves:**

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1. **Draw a picture of what the shoreline looks like before any waves:**

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4. **Gently make 20 waves along the shoreline. Mark where the sand stops with another piece of tape on the outside of the shoreline container.**

6. After all of the waves, did the shoreline shrink any?

7. **Use a ruler to measure how far the sand traveled from the first piece of tape you added to the last piece of tape you added.** How many millimeters did the shoreline move back from the start of the experiment to the end? How many centimeters?

8. **Draw a picture of what the shoreline looks like after all 20 waves:**

Review Questions

PART 1: Work with your group to answer the questions below:

1. Which shoreline lost the most sand during the wave experiment?

2. Which shoreline kept the most sand during the experiment?

3. What happened to the sand? Where did it go? Why did this happen?

4. What do you think the shorelines would look like if a hurricane came?
   - Only Sand:
   - Bulkhead/Seawall:
   - Living Shoreline with plants:
   - Living Shoreline with plants and oyster reef:

5. What do you think the shorelines would look like half a year after a hurricane?
   - Only Sand:
   - Bulkhead/Seawall:
   - Living Shoreline with plants:
   - Living Shoreline with plants and oyster reef:

6. How do you think the plants and oyster reefs can help keep the surrounding waters clean?

PART 2: On your own answer the questions below:

1. If you had a home in front of the shore, which type of shoreline would you want? Why would you want that shoreline instead of another one?

2. Which shoreline do you think would be a better home for fish and other animals?

3. Why do you think the shorelines with plants and oyster shells were called “living shorelines”?